Background and Rationale. Relative Energy Deficiency in Sport (REDs) is a syndrome that can affect athletes regardless of sex, type and level of sport [1]. Its prevalence in sport can range from 22 to 58+% of athletes [2]. It is underpinned by prolonged and/or severe low energy availability (under fueling) that leads to impaired physiological functioning in metabolic rate, endocrine function, bone health, immunity, protein synthesis and cardiovascular health. These deleterious features adversely impact performance, wellbeing, and lead to poor health outcomes [1]. The prevention, early detection and treatment of REDs is essential for athlete health and can positively affect the trajectory of their athletic careers, as it can take upwards of 1-2 years to recover from severe cases of REDs [3]. Sport dietitians are central in the prevention, management, and treatment of REDs as part of an interdisciplinary team. Despite a physiological understanding of the widespread and detrimental impacts of REDs, its diagnosis and treatment remain challenging. The 2015 International Olympic Committee (IOC) REDs clinical assessment tool (REDs CAT) guides clinicians in its screening and management [4]. Athletes are categorized based on level of REDs severity/risk: low (green), mild (yellow), moderate (orange), and severe (red). While this tool is available for clinicians, there is a scarcity of athlete-appropriate resources available to help them understand REDs, their personal severity/risk level, and what to do to prevent or improve their severity/risk status, of which working with a sport dietitian is a critical component. This is especially relevant since knowledge and awareness of REDs may be low among coaches, trainers, and athletes [5]. Athlete knowledge, beliefs, and behaviours play a critical role in preventing and managing REDs and health interventions and resources grounded in behavioural theory are more effective than those without theoretical foundations [6-8]. For example, one intensive nutrition education intervention for male cyclists at risk of REDs demonstrated improvements in bone health and race performance after 6 months, suggesting that nutrition education in an athlete population can yield positive health and performance outcomes [9]. However, it is unknown if a pragmatic intervention at the point of REDs screening for all athletes (regardless of severity/risk level, sex, type and level of sport) can improve REDs-related knowledge, attitudes and behaviours. Our research will address this gap by developing a validated personalized REDs severity/risk report for athletes, to enhance knowledge and promote behaviour change. With the systematic development of a report, informed by REDs clinical experts, behaviour change theory and athletes (end-users), we hypothesize that such a resource will serve as a pragmatic intervention to enhance athlete's awareness, knowledge, attitudes and intended behaviours related to REDs; ultimately leading to earlier treatment with sport dietitians, and better health and performance outcomes.

Objectives. The overall purpose of this research is to develop and evaluate a novel REDs severity/risk report that will serve as a personalized educational intervention (based on REDs severity/risk) to support improvements in REDs-related knowledge, awareness, attitudes, and behaviours. In Study 1, we will define and refine the goals, content, communication tactics, and other impactful features of the report. We will then create an initial report. Next, we will maximize the usability and acceptability of the report in multiple successive rounds of iterative testing based on athlete feedback. In Study 2, we will conduct a proof-of-concept study to assess the impact of the report on athlete REDs-related knowledge, attitudes, and intended behaviours (KAB). Between group differences in KAB and retention and sustained change over time will be assessed with an intervention group (individualized report that pertains to their severity/risk level) and control group (generalized REDs pamphlet).

Methodology. This research is guided by the IDEAS Framework and ORBIT model, which are evidenced-based frameworks for the development of behavioural interventions [10,11]. The participant population for both studies reflects the following inclusion/exclusion criteria: Canadian male and female development and elite athletes currently and actively training for and competing in Olympic and Paralympic events, > 15 years of age and not pregnant.

Study 1, Phase 1: Report Development (July to Sept 2023). The purpose of Phase 1 is to refine the report goals and identify features to clearly communicate severity/risk and better engage athletes in individualized REDs severity/risk-reduction education. This formative multi-method research design includes a review of the literature, behavioural theory and stakeholder discussions. The main output of this Phase 1 is to generate a distinct REDs severity/risk report (paper/PDF) for each of the REDs CAT severity/risk levels (4 levels: low, mild, moderate and severe). A literature review will examine behavioral studies related to REDs and low energy availability, risk assessment tools, and health communication. Using our networks, we will conduct an exhaustive search of currently available REDs resources. We will also hold 2 group discussions with stakeholders to gain an understanding of their priorities, values, and motivations related to REDs, which are insights that will guide report development (60 min each, virtual). The first discussion group will include 9 REDs experts (e.g., dietitians, physiologists, physicians) and the second group will include 6 athletes. Prior to the meeting, participants will complete an online questionnaire (Qualtrics survey platform) to capture priorities to guide the discussion. The data obtained from the literature and stakeholder discussions will allow us to determine the goals, content, communication tactics, and other impactful features of the REDs severity/risk report intervention, supporting the development of a report with high face and content validity. To develop an initial draft of the report, these data will be integrated with constructs defined by behavioural change models (e.g., Health Belief Model, Theory of Planned Behaviour) and the Behaviour Change Techniques Taxonomy [12] to ensure a report that has high potential to stimulate behaviour change, and ultimately improve health outcomes. Using the knowledge generated from this formative research, with a graphic designer we will develop a REDs severity/risk report for each of the 4 severity/risk levels. The report will be developed using the infographic design platform Piktochart which has high design capability and flexibility.

Study 1, Phase 2: Iterative Testing of the Report in the Target Population (Sept to Dec 2023). In Phase 2, the REDs severity/risk reports generated in Phase 1 will be tested with athletes using an iterative user testing study design with 5 iterative testing sessions (virtual, 60 min each, n=5-6 unique athletes/session). Iterative design changes resulting from each testing session will be implemented in rapid succession. The main outcomes assessed by athletes at each testing session include report usability and acceptability (assessed via questionnaire and qualitative feedback). Participants will not have participated in previous testing sessions and will be chosen to reflect a diversity of higher and lower severity/risk REDs sports, gender, and level of sport. Athletes will be recruited using email and social media platforms. *Testing Protocol:* Prior to the meeting, participants will be sent the 4 reports, along with a questionnaire capturing demographics, health literacy, and REDs knowledge and attitudes. After reading the report, participants will complete a usability and acceptability questionnaire (13 items rated on a Likert scale, 10 minutes) which has been developed by our team for this study. Next, participants will attend a virtual meeting to share their feedback verbally (60 min, virtual, audio recorded). This process will be followed until the reports have been optimized based on athlete feedback. The questionnaire data will be

analyzed after each testing session using descriptive statistics including mean, median, mode, and standard deviation. Content analysis will be used to analyze the qualitative data.

Study 2: Proof-of-concept study (Jan to Dec 2024). Next, we will conduct a proof-of-concept study using a parallel randomized controlled trial design to test the hypothesis that use of the REDs severity/risk reports by development and elite athletes, will improve their REDs-related knowledge (e.g. ability to define REDs and identify symptoms), attitudes (e.g. attitudes related to severity/risk, prevention, performance) and intended behaviors (e.g., intention to book a consultation with a sport dietitian). Athletes will be randomized to an "intervention group" who receives the personalized REDs severity/risk report (n=25) or to a "control group" that receives a general REDs educational pamphlet (n=25). *Protocol:* Participants will undergo REDs screening with a sport medicine physician using the REDs CAT criteria (e.g., demographics, blood work, bone density), and be classified into a corresponding severity/risk level (low, mild, moderate or severe). Participants will then attend a virtual laboratory session. During the session, participants will receive the report that pertains to their severity/risk level (intervention group) or a REDs educational pamphlet (control group). Participants will have has long as needed to independently review the report. Changes in REDs-related knowledge, attitudes and intended behaviours will be assessed at the beginning and end of the laboratory session, using a questionnaire our team developed for the purpose of this study (30 items, 20 minutes). A follow-up questionnaire will be administered 4 weeks later to assess retention and sustained change, as well as the actual behaviours implemented. Questionnaires will be administered by a team member blinded to study group allocation. Between group differences and changes over time will be analyzed using the Kruskal-Wallis test. Subgroup analyses will be conducted to determine the impact of the report based on the REDs severity/risk, gender, and sport, which may influence responses to the report.

Relevance to Dietetic Practice. By developing personalized reports based on REDs severity/risk, this research will support the prevention of REDs among low REDs severity/risk athletes and REDs treatment-seeking behaviors among moderate-high severity/risk athletes, to improve health and performance. The findings will also promote the involvement of sport dietitians (leading to increased referrals) as part of the interdisciplinary sport management team, enabling them to being central to REDs prevention and management. This research aligns with the CFDR mandate related to Critically (Re)Thinking Dietetic Practice and Evaluate Effectiveness of Clinical Interventions. Given that our team members are international REDs experts at the IOC, the report generated in this study has the potential to be implemented globally as part of standard practice during REDs screening and diagnosis.

Budget. Total = $12,635. Expenses for 2023 (total amount for 2023 = $9385)

- Graphic designer for initial and iterative design (Study 1) - $7500
- Pikotchart subscription - $250
- Gift card honorariums: Study 1 Phase 1 experts (n=9 x $50), athletes (n=6 x $25), Study 1 Phase 2 athletes (n=30 x $25) - $1350 total
- Qualtrics professional survey platform subscription (annual) - $1500/ year

Expenses for 2024 (total amount for 2024 = $3250)

- Gift card honorariums: Study 2 athletes (n=30 x $25 each) - $750 total
- Qualtrics professional survey platform subscription (annual) - $1500/year
- Dissemination of Results - Own The Podium Sport Innovation Summit - $1000

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